High-Efficiency, Digitally Calibrated T/R Modules Enabling Lightweight SweepSAR Architectures for NISAR-Class Radar Instruments

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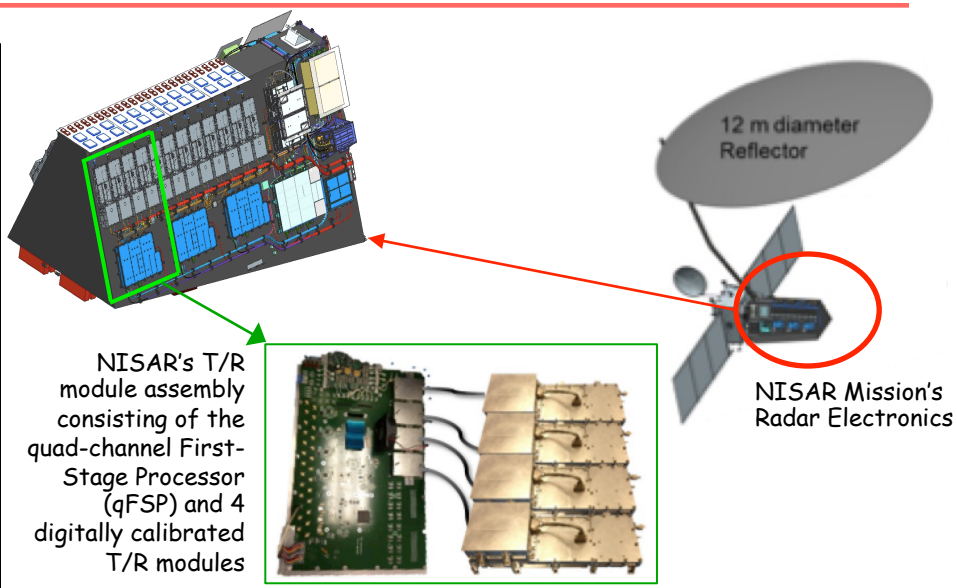
Objective

- Develop and demonstrate a next-generation digitally calibrated, highly scalable, L-band Transmit/Receive (T/R) module to enable a precision beamforming SweepSAR (Synthetic Aperture Radar) architecture for interferometric radar applications and phase-stable electronically steered arrays.
  - 0.1 dB amplitude, 0.5 degrees phase.
- Develop technologies to enable real-time on-board beamforming capability for use in phase-stable array antennas:
  - High efficiency L-band T/R module.
  - Closed-loop transmit and receive calibration circuitry.
  - On-board real-time digital calibration and beamforming.



Accomplishments

- Designed and developed a new digitally calibrated T/R module architecture, including hardware and algorithm, for the NISAR-class L-band radar instrument. Specifically:
  - Prototyped the T/R module with improved layout for RF isolation and calibration circuitry, and demonstrated a 41% RF efficiency - nearly a factor of two improvement over the UAVSAR T/R module efficiency
  - Prototyped the qFSP for digitizing signals, estimating calibration signal amplitude and phase using built-in algorithms, and controlling attenuators and phase shifters, on four T/R modules
  - Developed a novel multi-path calibration scheme for characterizing transmit, receive, and feed circuitry separately
- Designed and developed the testbed and process for testing multi-channel SARs
- Integrated and tested the digitally calibrated T/R module assembly, and demonstrated close-loop calibration with performance meeting NISAR requirements (better than 0.1 dB amplitude and 0.5° phase variations after pulse averaging)
- The T/R module architecture and testbed have been adopted for NISAR flight instrument development

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$TRL_{in} = 3$ $TRL_{out} = 5$